



# RCA INSTITUTES

INC.  
formerly  
MARCONI INSTITUTE  
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## Technical Lesson 33-A

### BUILDING THE BATTERY-OPERATED SCREEN-GRID RECEIVER

In theory of operating there is little difference between the battery operated receiver and the receiver operated from alternating current lines. The chief difference lies in the manner of obtaining the necessary potentials to supply the filaments, grids and plates of the tubes. Since a battery operated receiver is designed to obtain its current supply from batteries, and all batteries supply direct current, many of the problems encountered in alternating current operation of receivers are done away with. Inasmuch as there is no "hum" to deal with in battery sets they do not require special heater type tubes and elaborate filter systems which are essential to the most satisfactory operation of a-c receivers.

Our battery-operated receiver is tuned in exactly the same manner as the a-c set and also the detector demodulates the incoming signal wave to provide an audio-frequency current which is amplified through the audio stages in the usual way, which has been explained in former lessons.

From our previous explanations it should be clear how the signal wave sent out by a broadcasting station is intercepted by a receiving antenna, and how the energy induced in the antenna wires is conducted through the primary of the first radio-frequency transformer to the earth and, also, how the signal as it passes through the primary sets up a varying magnetic field which induces a current having characteristics similar to the radio wave into the secondary of this transformer. When the secondary is tuned carefully with a variable condenser to resonate this circuit to the same frequency as that of the desired signal then the highest value of signal current will flow. The signal current thus obtained is used to operate the first vacuum tube by varying the voltage on its grid which in turn controls the flow of electrons between filament and plate. In other words, since these electrons are the plate current we have a direct current flowing in the plate circuit that varies in exact accordance with the grid voltage variations.

In our receiver, however, there is a potentiometer located ahead of the r-f transformer to act as a volume control. The amount of signal voltage applied to the 1st r-f circuit depends upon the position of the movable contact arm on the resistance wire of the potentiometer.

From experience we know how quickly an r-f tube will break into oscillation when a comparatively strong signal is applied to the grid due to the capacity coupling between the plate and grid elements. This condition whereby energy is transferred back and forth between plate and grid circuits is popularly known as "feed-back" and is undesirable in circuits of this type. The screen-grid tube is designed especially to overcome this difficulty. A fourth element known as a screen grid or space charge grid is placed between the control grid and plate of this tube. When the screen grid is supplied with the proper

positive potential with respect to the plate and control grid it will reduce the capacity between grid and plate to a negligible amount and thus prevent this undesirable feed-back. The use of the screen grid permits a strong signal voltage to be applied to the grid and naturally a greatly amplified signal can be taken from the plate without creating a feed-back condition. Furthermore, due to the action of the screen grid a high potential can be applied to the plate of the tube which also results in greater amplification. When the plate current varies within greatest limits it delivers a large signal energy to the primary of the next r-f transformer, and this stronger energy will in turn be amplified considerably more as it passes through each succeeding r-f stage until it reaches the grid of the detector tube. The detector tube is adjusted to function on the audio-frequency component of the received signal.

After the incoming signal energy is strengthened through two successive stages of r-f amplification it still retains its original wave form, but after acting on the detector grid this energy is demodulated by the detector action and produces an audio-frequency current in the output of the detector. Therefore, after the signal passes through the detector we have no further use for the radio-frequency component of this signal. Consequently, we make every effort to keep the r-f out of the a-f circuits by choking it back with an r-f choke coil and furnishing a path for it to flow through with a by-pass condenser connected between the plate and the low potential side of the circuit. Hence, only the audio-frequency component as represented by the modulation, or varying amplitudes of the r-f oscillations, is allowed to pass to the audio system.

Reviewing the explanations concerning an audio-frequency amplifier it should be clear that the principles governing the action of an a-f amplifier are quite similar to those of an r-f amplifier, the difference being mainly that the radio-frequency amplifier is concerned with the r-f component of the signal, whereas the audio-amplifier handles only the a-f component. Because of the wide difference between the two frequencies, that is, between radio and audio frequencies, we must use transformers of special design to handle these frequencies. Therefore, we use air-core transformers in the r-f stages and iron-core transformers in the audio-amplifier stages. The process of amplifying the audio output of the detector is repeated in each succeeding a-f stage until the signal is sufficiently strong to operate the loudspeaker.

PUSH-PULL AMPLIFIER. Our receiver is designed to operate either a magnetic or dynamic type speaker with ample volume and good tone quality by employing two power tubes in the last stage of the audio amplifier. The tubes are arranged in what is termed a push-pull system of amplification, the name being derived from the principle upon which the tubes work together. When tubes are connected in this manner the grid potential of the one tube is positive with respect to the filament when the grid potential of the other tube is negative with respect to its filament. Thus, each tube works on opposite ends of the same wave, as it were, one pulling and the other pushing, and since there is a complete reversal of polarity during each cycle the tubes reverse their action, and in this way both tubes are always adding their effective changes in the energy delivered to the speaker circuit. Notice that the secondary winding is tapped in the center and a connection is carried from this point to the -45 volt terminal of the "C" battery to supply the requisite negative bias to the grids. Since each grid is attached to opposite ends of the secondary winding the alternating voltage generated in each half is applied to the respective tubes.

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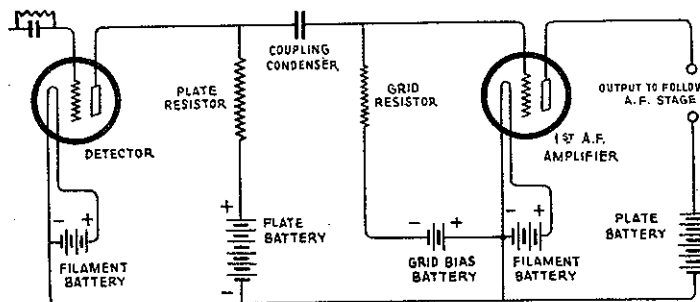
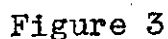
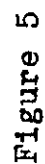


Figure 2

Figure 2 shows the essential pieces of apparatus required for resistance coupling which consists of a plate resistor, a grid resistor, and a coupling condenser. As explained in a former lesson an audio-frequency voltage is generated across the plate resistor by the varying plate current passing through it, and it is this varying voltage that is impressed first on the coupling condenser and thence on the grid of the first audio amplifier. The coupling condenser isolates the d-c plate current of the detector from the grid circuit of the audio tube. The grid resistor is required to provide a path for the electrons collected by the grid to return back to the filament, the electrons representing the flow of grid direct current. The "C" battery of the first audio amplifier maintains a bias of  $-9$  volts on the grid.







CLASSES OF RECEIVERS. Radio receivers can be divided into three classes according to the source of e.m.f. from which they derive their power, as follows:

- (1) Battery-operated receivers which derive their power entirely from batteries,
- (2) Direct-current electrical receivers which take their power directly from d-c power lines, and
- (3) Alternating-current receivers which obtain their supply from alternating-current power lines.

Alternating-current receivers are rapidly replacing the battery-operated type in many localities where a-c line supply is available. It is certain, however, that there will always be some battery-operated receivers in use, especially for portable use, and in places where there are no electric power lines.

The Battery-Operated Receiver described in this text has incorporated within it the best features which we have discussed in other paragraphs. Figure 3 is a schematic diagram of the circuit of this receiver showing two stages of r-f amplification employing UX-222 type screen-grid tubes, a detector and one stage of resistance-coupled audio amplification employing UX-112-A type tubes, and finally a power stage employing two UX-171-A type tubes in push-pull arrangement. The output of the power tubes is delivered to an output transformer which is designed to furnish the correct impedance to the external plate circuit, and at the same time through its transformer action allows any type speaker to be used. Figure 4 is a pictorial diagram giving the names of all the parts.

#### BATTERIES AND TUBES REQUIRED.

The following tubes, or their equivalent are required for battery operation.

|              |                                        |
|--------------|----------------------------------------|
| Two UX-222   | (Screen-grid r-f amplifiers.)          |
| Two UX-112-A | (Detector and 1st a-f amplifier.)      |
| Two UX-171-A | (Power amplifiers in push-pull stage.) |

The following batteries are required.

|                                                     |
|-----------------------------------------------------|
| Four 45 volt "B" Batteries.                         |
| Two 22½ volt small sized "C" Batteries.             |
| One 6 volt Storage Battery, called the "A" Battery. |
| One 4½ volt "C" Battery.                            |

#### CONSTRUCTIONAL DETAILS.

The board that you must procure for mounting the parts should be well seasoned so that it will lie flat and never warp. It should be a white wood or pine board free from knots, 12 inches wide, 20 inches long, and about 7/8 inch thick. If sandpapered and given a coat of stain its appearance will be improved.

The following tools are required for constructional work: A good soldering iron (use an electric iron if possible), a medium-sized screw driver, a small screw driver for tightening set screws, a pair of long-nose pliers for holding wires while soldering them, a pair of side-cutting or diagonal-cutting pliers, a knife, and a rule for measuring the lay-out of the parts for mounting.

Figure 5 is a dimensional drawing showing the exact relationship of the parts when mounted. The first thing to do is to measure off the center lines on the

board for each part according to the measurements given in the drawing, making only a light mark with a lead pencil in the proper location. Now place the parts on the board just as the drawing illustrates, making sure that each part is turned in the proper direction. With a sharp pointed instrument such as an awl, or a wire nail, mark the location where the screws will enter the wood in mounting each part and then clear the board of all parts and make a small hole at each screw location thus marked to allow the screws to take hold easily. If the starting hole is made too large the screw will not hold securely when the parts are mounted, so be careful when doing this work.

We will call the edge of the board on which the panel is to be mounted the "front" of the board. Lay the board on a table or work bench with the front facing you and your dimensional drawing placed nearby for ready reference, and commence at the left end of the board and mount the transformers. The two output terminals of the output transformer should face in the direction toward the front edge of the board, and the two input terminals, marked P and B, of the input transformer should face in the direction toward the back edge of the board. Next proceed to mount the sockets, being careful to place them so that their filament terminals, marked FF, are in the direction toward the left end of the board. Now mount the by-pass condensers, choke coils, r-f transformers and other parts as indicated in the drawing. However, do not mount the r-f transformer shields until the receiver has been completely wired and checked for possible errors in wiring.

The "LOCAL-DISTANT" switch should be assembled on the small panel strip containing the five spring-type terminals. First remove the outside nut and "OFF-ON" plate from the switch and then insert the switch into the large center hole so that the shaft and toggle protrude through the front of the panel, and then replace the "OFF-ON" plate and turn the switch so that the "OFF" position is at the bottom. Again remove the "OFF-ON" name plate, being careful not to turn the switch in doing so, and put on the outside nut and tighten. The name plate must not remain on the switch because the proper names "LOCAL and DISTANT" are engraved on the panel. The battery switch must be assembled on the large panel in much the same manner as the assembly of the "LOCAL-DISTANT" switch on the small panel, except that the "OFF" position should be located at the top and the "OFF-ON" plate is to be used and secured in position with the switch. It may be necessary to enlarge the hole in the large panel before mounting the battery switch, which can be done easily with a round file.

The volume control should next be assembled on the large panel and held in position by the nut provided for this purpose after first removing the knob from the shaft. The knob is held by a set screw which must be loosened. When the volume control is in place remount the knob and push it over the end of the shaft as far as it will go, and with a small screw driver tighten the set screw firmly. With these parts mounted attach the large panel to the front edge of the board, as illustrated in the drawing, by means of two wood screws inserted through small holes. The small panel strip carrying the spring terminal posts and "LOCAL-DISTANT" switch is attached immediately to the left of the large panel and held by means of small screws. Next locate the position for mounting the 3-gang tuning condenser by inserting its shaft through the central hole in the panel. The three hexagon adjusting nuts should be toward the top. Slip the dial over the end of the shaft and tighten the dial set screw so that the condenser shaft will rotate with the dial. After this is done move the 3-gang condenser either forward or backward and to either side if necessary, until

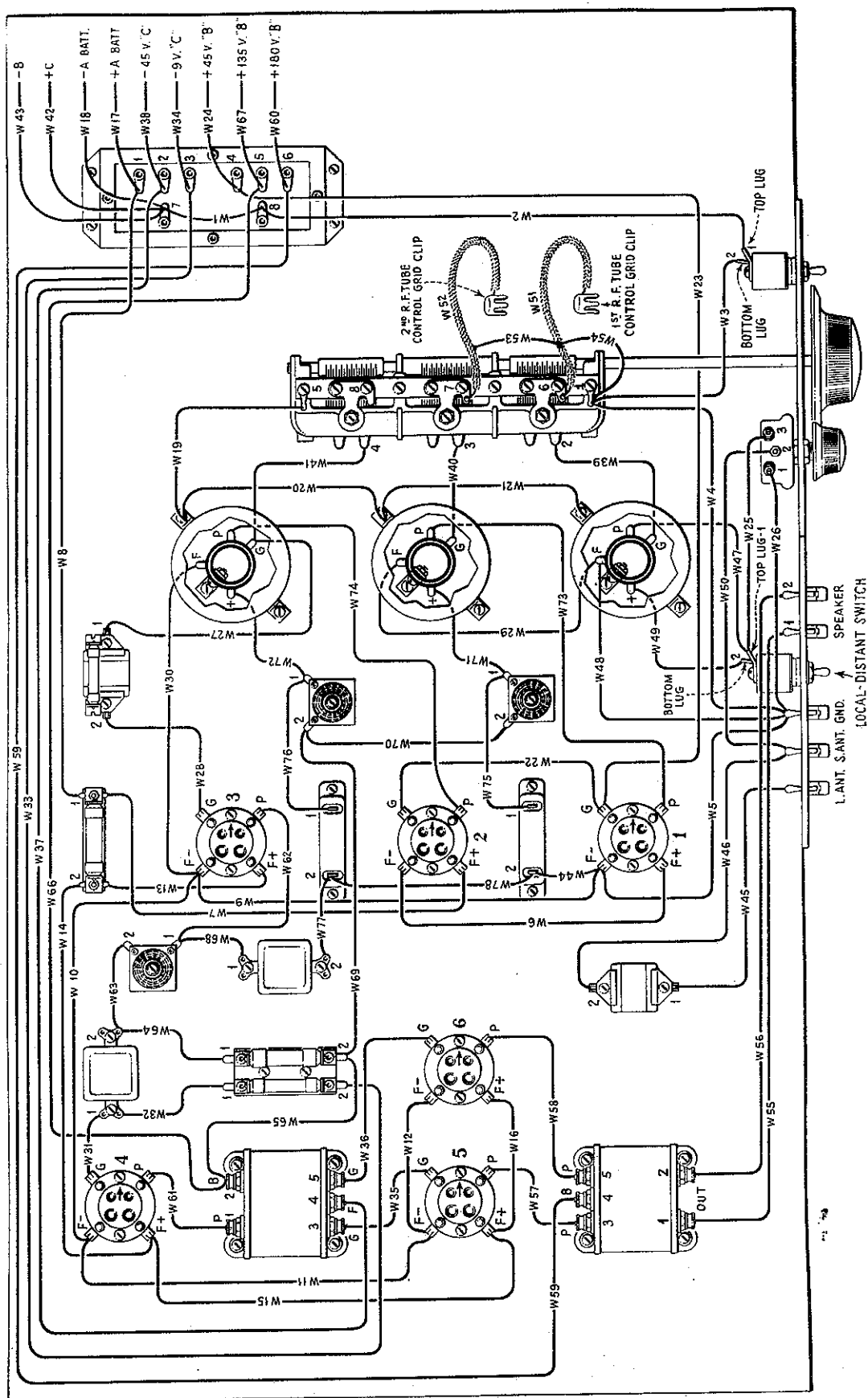


Figure 6



the dial just clears the panel. Be sure the clearance space is equal all around the dial so that the dial when rotated will not touch or scrape the panel. Insert two wood screws through the two holes in the bottom of the condenser frame and secure the condenser to the board. Be sure that the plates of the gang condenser are fully meshed (closed) while working with it, otherwise the plates might become bent or damaged. With the condenser plates fully meshed and the frame securely fastened to the board, loosen the dial set screw and rotate the dial on the condenser shaft until the 100 mark on the dial coincides with the line engraved on the panel above the dial, and when this position is found again tighten the set screw.

The condenser block should now be mounted as indicated on the drawing at the right of the board and toward the back edge. The condenser block is primarily intended for use in conjunction with the a-c receiver and is not essential to a battery-operated receiver. However, since it is available we will utilize it for two very good purposes, namely, as a terminal strip to which we can bring all of our power circuit leads and there join them to the battery cable leads and, also, the condensers in this block are made to serve as by-passes across each battery thus keeping all r-f currents out of the battery circuits which of course is desirable. Figure 6 is a picture drawing of the arrangement of parts with the circuits all completely wired.

The accompanying wiring chart has been prepared to aid the student in properly wiring his receiver. In the column headed "CIRCUIT" are the names of the different portions of the receiver wiring to which the information in the other columns apply. For example: The word "Filament" in the "CIRCUIT" column indicates that the data given in each of the columns reading to the right and across the page pertains to the wiring of the filaments from the tubes to the filament supply. This column shows that there are 18 wires, numbered from W1 to W18, inclusive, needed for the filaments. The column headed "WIRE NUMBER" designates by number each of the individual wires in the circuits of the set.

It will be observed that the wires illustrated in the wiring drawing bear the same designating numbers as those appearing in the "WIRE NUMBER" column. The next column designates the color of the wire to be used for any particular number as given in the number column. The column headed "FROM TERMINAL" gives the terminal number and name of part to which one end of a particular wire is to be attached. The next column headed "TO TERMINAL" gives the terminal number and name of part to which the other end of this wire is to be attached. This method of plainly designating each part and numbering all the terminals and identifying each wire makes the instructions very easy to follow.

The Following Are Practical Examples of How to Use the Chart. Referring to the wiring chart under "Filament" circuit it will be noticed that the first wire listed is numbered W1. We find in the next column that W1 is a piece of "bus wire," which is the name given to a length of solid tinned wire found in the kit of parts. In the next column we find that one end of wire W1 should be connected to terminal marked #7 on the drawing, which is one of the terminals on the condenser block. Referring to the next column we see that the other end of this wire is connected to a terminal marked #8 on the drawing, which is another terminal on the condenser block. About 1/4 inch from each end of the bus wire make a short hook by bending the wire at right angles to the length so that the short bent-over ends can be inserted into the holes in the solder lugs, after which these connections should be soldered.

Again referring to the chart we will consider the next wire which is numbered W2. We see that a black colored wire is selected for this connection, one end of which is to be soldered to lug marked #8 on the condenser bank and the opposite end to terminal marked #1 on the battery switch or "OFF-ON" switch.

It is unnecessary for us to follow out every connection and wire in this description. That is the purpose of making up the chart. Thus, the chart should be consulted when connecting each wire and the instructions followed carefully in order to avoid errors in wiring the receiver. It would be a good plan to place a check or a cross (x) after each number identifying that particular wire in the chart and, also, check or cross the corresponding wire on the wiring diagram. This will aid you in keeping track of your work.

Every connection in the circuit should be carefully soldered and in no instance should you ever attempt to solder a wire to a screw or binding post; always solder to a lug provided for that purpose. If screws or binding posts are not equipped with lugs then put them on yourself. A supply of lugs will be found among the parts in the kit. The audio transformers, chokes, local-distant switch, volume control and so on, should all have solder lugs attached.

After it is decided where the batteries are to be placed then measure the lengths of the different wires necessary to connect between the terminals on the batteries and the terminals on the condenser bank. It is suggested that the batteries be kept within a reasonable distance from the set since very long battery leads have been known in cases to reduce the applied potentials to values lower than required for satisfactory operation. Notice that battery leads marked +C, -B, and -A are all of the same color and all connect to the same terminal on the condenser bank. Since this terminal is common to these three leads it does not matter which leads are used for +C, -B, and -A. Each battery lead should be identified with a tag marked A, B, or C, and with the polarity + or - and the proper voltage to avoid confusion and possible error at some later time when servicing the set to renew batteries.

All wires after being cut to their proper lengths should be cleaned and tinned at both ends so that the solder will take hold easily when the wires are soldered later to the terminals. In a case where more than one wire is to be connected to the same terminal, the wires should be twisted together before tinning and then the group should be tinned and soldered at the same time to the terminal. Do not make your wires too short, but prepare them long enough so they will easily reach around or between parts and around bends as shown in the drawing.

When the construction is completely finished you can make a neat and workman-like job of the wiring if you like by lacing together any wires which run parallel or side by side for any distance. To do this simply tie the leads together at intervals of about two or three inches. Do not lace any grid wires which run from sockets to transformers in a cable with other wires. This applies especially to wires which carry r-f currents.

The wires numbered W19, W20, and W21 should be twisted first and then inserted into the respective eyelets of the aluminum shield cans and then soldered. These are the eyelets used to hold the mounting brackets. It is useless to try to solder to the aluminum can, or shield, because a special solder and flux are necessary for soldering wires to aluminum. You should solder to the eyelet as just suggested.

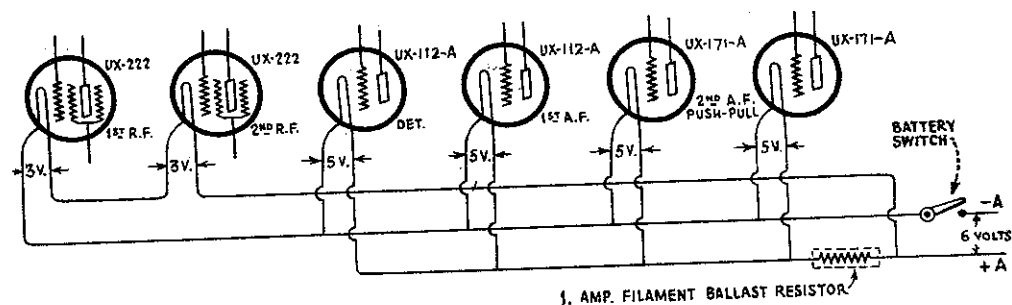


Figure 7

Figure 7 is a schematic diagram of the filament circuit for our d-c receiver when employing a 6 volt storage battery for filament supply.

It will be noticed that while all other tubes have their filaments connected in multiple, or parallel, the first and second tubes, which are of the screen grid type, have their filaments connected in series and in turn their outside leads are connected in parallel with relation to the other tubes. This method of connection is necessary because the 112-A and 171-A type tubes both require 5 volts to supply their filaments, whereas each of the 222 type tubes require only 3 to 3.3 volts.

Since we will use a 6 volt storage battery for filament supply we can operate the two 3 volt tubes in series directly across the battery as just explained. However, since all other tubes require 5 volts we must insert a resistor in series with them after they are first connected in parallel to reduce the 6 volts supplied by the battery to the 5 volts required.

Let us repeat that an e.m.f. of 5 volts is supplied to each of the 112-A and 171-A tubes, but that 6 volts is not too much for the two 222 tubes provided the latter are connected in series. Observe that the positive side of the 222 tube circuit is carried to the battery side of the filament resistor.

It should be noted that there is a slight difference in design between the first r-f transformer and the second and third. The second and third are alike in every respect and therefore they may be used interchangeably, but the first transformer, which has one terminal common to both primary and secondary, can be used in only one location as shown in the diagram, that is, it is used as the first r-f transformer. The latter is easily identified by the comparatively short tube located within the long outer tube. The secondary coil is wound on the long outside tube and the primary coil on the inside tube. Schematic sketches of the wiring of each type of transformer are shown in Figure 4.

#### How to Prepare the Two Shielded R-F Screen-Grid Wires.

Figure 8 illustrates how to prepare the two shielded grid leads. These shielded leads are used to connect the control grids of the 222 tubes to the respective circuits by soldering one end of each wire to the proper lug on the top of the 3-gang condenser as shown. A cap is soldered to the other end of each wire, the cap being cup-shaped to fit over the metal top on the tube.

Notice how the braided wire, or shield, is pushed back on the rubber insulation for about 1/4 inch at each end and solder flowed around the braided wire near the end to prevent the shield from slipping back and making possible contact with the copper wire which it encases.

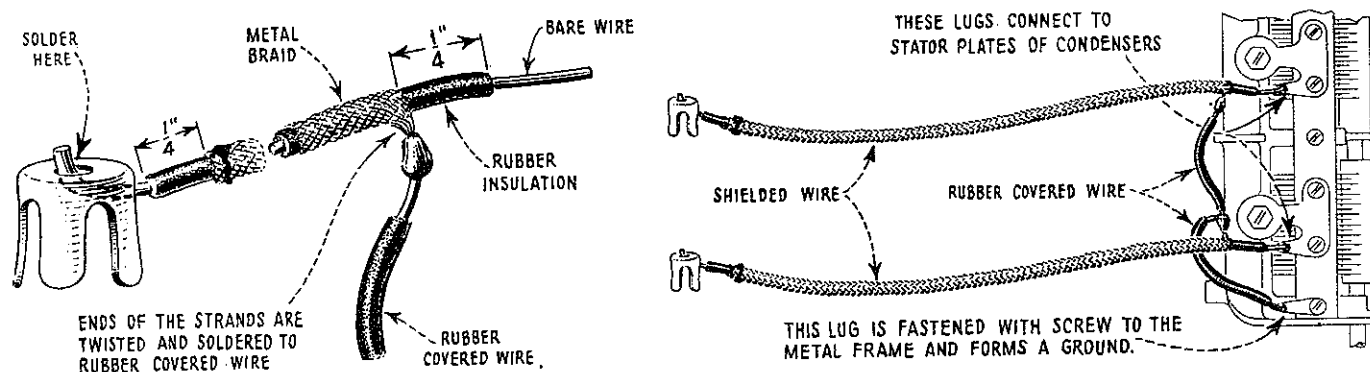


Figure 8

When the wiring is completed a continuity test should be made before the batteries are connected or the tubes inserted in their respective sockets to make sure no error has been made that might result in damage to any of the parts or tubes. Figure 9 illustrates how a "C" battery and a pair of headphones are connected in series to make this test. One tip of the phone cord is connected to one terminal of the battery and a piece of wire to the other terminal of the battery thus providing two test leads as shown in the sketch

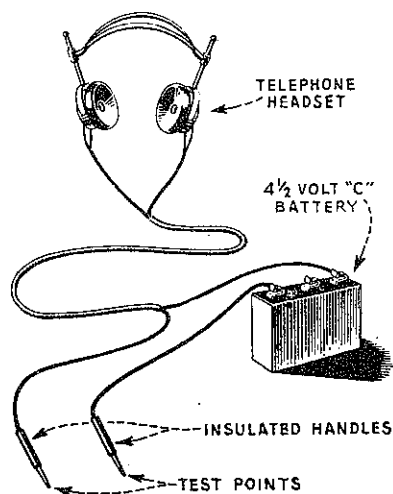


Figure 9

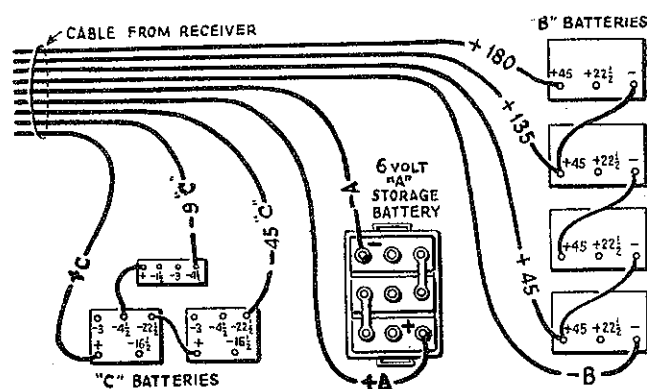


Figure 10

The procedure for this test is as follows: Place the phones over your ears and touch the end of one test lead to either one of the filament terminals on the first socket and the end of the other test lead to the plate terminal on the same socket. When contact is made a slight click will be heard because the by-pass condenser will be charged and discharged. However, if this connection is made and broken repeatedly by tapping the terminals with the test leads the click should become steadily weaker and finally seem to disappear

altogether. If the click should be strong and pronounced each time the terminals are touched with the test leads it is an indication that there is a short circuit between the plate and filament wiring and the wiring should then be checked for wrong connections and inspected at crowded terminals where there is the possibility of a bare wire touching the wrong terminal of some socket. When making this test the battery switch should be turned on and all battery leads separated so that the bare ends of the wires do not touch one another.

When the continuity test has been completed and you are satisfied that the wiring is correct in accordance with instructions the batteries should be connected as illustrated in Figure 10. Next insert the tubes in their respective sockets being sure to place the 222 tubes in sockets 1 and 2, the 112-A tubes in sockets 3 and 4, and the 171-A tubes in sockets 5 and 6. The clips on the ends of the two shielded leads which come from the first two sections of the 3-gang condenser should be connected respectively to the metal caps on the tops of the 222 tubes.

When the set is located near a broadcasting station satisfactory results are usually obtained with an indoor antenna, however, if this is not the case or if the set is situated a considerable distance from a station an outdoor antenna must be installed. To find out just what type antenna is best suited to a particular location sometimes requires a little experimentation. Reference should be made to our lesson on antennas. In general, if an outdoor or indoor antenna is used and does not exceed seventy-five feet in length measured from the far end to the set, then the lead-in should be connected to the terminal marked "S. Ant." If the antenna exceeds seventy-five feet the lead-in should be attached to the terminal marked "L. Ant." An indoor antenna can be easily made by installing about fifty feet of ordinary bell wire around the picture moulding. Gas pipes should be avoided for the purpose of making ground connections to radio sets.

**PRACTICAL OPERATION.** The receiver is ready for practical operation when the tubes have been inserted in their sockets, the batteries connected, and the antenna and ground connections made, and the phones or loudspeaker connected to the speaker terminals. To place the set in operation proceed as follows: First turn on the battery switch and next turn the volume control knob all the way to the right, that is, in a clockwise direction, and begin to rotate the condenser dial back and forth slowly from one end to the other and at some point you should tune in a broadcast signal. After you have picked up a station in this way, then reduce the volume to the desired level. To reduce volume never detune a receiver by moving the dial away from the point of resonance because it spoils the quality of the reproduction. Always use the volume control for this purpose.

**HOW TO ADJUST THE THREE TRIMMER CONDENSERS.** After a station has been properly tuned-in on the receiver then with any type of screw driver adjust each trimmer condenser in succession by turning the large slotted hexagon screw either in a clockwise or counter-clockwise direction until the greatest volume is obtained for each adjustment. Do not touch the volume control or move the tuning dial when performing this work because you can only judge each adjustment by the volume of sound at a given signal frequency. Be very careful to make the best adjustments possible in each case because the efficiency of the set in general will depend upon how perfectly the r-f circuits are synchronized.

# WIRING CHART FOR BATTERY RECEIVER

| <u>CIRCUIT</u> | <u>WIRE<br/>NUMBER</u> | <u>WIRE<br/>COLOR</u> | <u>FROM<br/>TERMINAL</u> | <u>TO<br/>TERMINAL</u> |
|----------------|------------------------|-----------------------|--------------------------|------------------------|
| Filament       | W1                     | Bus-Wire              | #7 Condenser Bank        | #8 Condenser Bank      |
| "              | W2                     | Black                 | #8 Condenser Bank        | #1 "OFF-ON" Switch     |
| "              | W3                     | "                     | #2 "OFF-ON" Switch       | #1 Gang-Condenser      |
| "              | W4                     | "                     | #1 Gang-Condenser        | Gnd. Panel Strip       |
| "              | W5                     | "                     | Gnd. Panel Strip         | - F 1st R-F Socket     |
| "              | W6                     | "                     | + F 1st R-F Socket       | - F 2nd R-F Socket     |
| "              | W7                     | "                     | + F 2nd R-F Socket       | #1 Filament Resistor   |
| "              | W8                     | "                     | #1 Filament Resistor     | #1 Condenser Bank      |
| "              | W9                     | "                     | - F 1st R-F Socket       | - F Detector Socket    |
| "              | W10                    | "                     | - F Detector Socket      | - F 1st A-F Socket     |
| "              | W11                    | "                     | - F 1st A-F Socket       | - F A-F Socket No.5    |
| "              | W12                    | "                     | - F A-F Socket No.5      | - F A-F Socket No.6    |
| "              | W13                    | "                     | #2 Filament Resistor     | + F Detector Socket    |
| "              | W14                    | "                     | #2 Filament Resistor     | + F 1st A-F Socket     |
| "              | W15                    | "                     | + F 1st A-F Socket       | + F A-F Socket No.5    |
| "              | W16                    | "                     | + F A-F Socket No. 5     | + F A-F Socket No.6    |
| "              | W17                    | Yellow                | #1 Condenser Bank        | + A Battery            |
| "              | W18                    | Black                 | #7 Condenser Bank        | - A Battery            |
| Shield         | W19                    | "                     | #5 Gang-Condenser        | 3rd R-F Shield         |
| "              | W20                    | "                     | 3rd R-F Shield           | 2nd R-F Shield         |
| "              | W21                    | "                     | 2nd R-F Shield           | 1st R-F Shield         |
| Screen-Grid    | W22                    | Red                   | G 2nd R-F Socket         | G 1st R-F Socket       |
| "              | W23                    | "                     | G 1st R-F Socket         | #4 Condenser Bank      |
| "              | W24                    | "                     | #4 Condenser Bank        | + 45 B Battery         |

# WIRING CHART FOR BATTERY RECEIVER (Continued)

| <u>CIRCUIT</u> | <u>WIRE<br/>NUMBER</u> | <u>WIRE<br/>COLOR</u> | <u>FROM<br/>TERMINAL</u>  | <u>TO<br/>TERMINAL</u>    |
|----------------|------------------------|-----------------------|---------------------------|---------------------------|
| Screen-Grid    | W25                    | Black                 | #3 Volume Control         | #1 Local-Distant Switch   |
| "              | W26                    | "                     | #1 Volume Control         | Gnd. Panel Strip          |
| Control-Grid   | W27                    | Green                 | G 3rd R-F Transformer     | #1 Grid-Leak Condenser    |
| "              | W28                    | "                     | #2 Grid-Leak Condenser    | G Detector Socket         |
| "              | W29                    | "                     | F 2nd R-F Transformer     | F 1st R-F Transformer     |
| "              | W30                    | "                     | F 3rd R-F Transformer     | - F Detector Socket       |
| "              | W31                    | "                     | G 1st A-F Socket          | #1 1st A-F Coupling Cond. |
| "              | W32                    | "                     | #1 1st A-F Coupling Cond. | #1 A-F Grid Resistor      |
| "              | W33                    | "                     | #2 A-F Grid Resistor      | #3 Condenser Bank         |
| "              | W34                    | "                     | #3 Condenser Bank         | - 9 Volt C Battery        |
| "              | W35                    | "                     | #3 Input Transformer      | G A-F Socket No.5         |
| "              | W36                    | "                     | #5 Input Transformer      | G A-F Socket No.6         |
| "              | W37                    | "                     | #4 Input Transformer      | #2 Condenser Bank         |
| "              | W38                    | "                     | #2 Condenser Bank         | - 45 Volt C Battery       |
| "              | W39                    | "                     | G 1st R-F Transformer     | #2 Gang-Condenser         |
| "              | W40                    | "                     | G 2nd R-F Transformer     | #3 Gang-Condenser         |
| "              | W41                    | "                     | G 3rd R-F Transformer     | #4 Gang-Condenser         |
| "              | W42                    | Black                 | #7 Condenser Bank         | + C Battery               |
| "              | W43                    | "                     | #7 Condenser Bank         | - B Battery               |
| "              | W44                    | Red                   | #2 1st By-pass Condenser  | - F 1st R-F Socket        |
| Antenna        | W45                    | Black                 | "L. Ant." Panel Strip     | #1 Antenna Condenser      |
| "              | W46                    | "                     | #2 Antenna Condenser      | "S. Ant." Panel Strip     |
| "              | W47                    | "                     | #1 Local-Distant Switch   | P 1st R-F Transformer     |
| "              | W48                    | "                     | F 1st R-F Transformer     | Gnd. Panel Strip          |
| "              | W49                    | "                     | + 1st R-F Transformer     | #2 Local-Distant Switch   |

# WIRING CHART FOR BATTERY RECEIVER (Continued)

| <u>CIRCUIT</u> | <u>WIRE<br/>NUMBER</u> | <u>WIRE<br/>COLOR</u> | <u>FROM<br/>TERMINAL</u>   | <u>TO<br/>TERMINAL</u>     |
|----------------|------------------------|-----------------------|----------------------------|----------------------------|
| Antenna        | W50                    | Black                 | "S. Ant." Panel Strip      | #2 Volume Control          |
| Control-Grid   | W51                    | "                     | 1st R-F Control Grid Clip  | #6 Gang-Condenser          |
| "              | W52                    | "                     | 2nd R-F Control Grid Clip  | #7 Gang-Condenser          |
| Shield         | W53                    | "                     | W51 Shield (braided wire)  | W52 Shield (braided wire)  |
| "              | W54                    | "                     | W51 Shield ( " " )         | #1 Gang-Condenser          |
| Plate          | W55                    | Red                   | #1 Speaker-Panel Strip     | #1 Output Transformer      |
| "              | W56                    | "                     | #2 Speaker-Panel Strip     | #2 Output Transformer      |
| "              | W57                    | "                     | #3 Output Transformer      | P A-F Socket No.5          |
| "              | W58                    | "                     | #5 Output Transformer      | P A-F Socket No.6          |
| "              | W59                    | "                     | #4 Output Transformer      | #6 Condenser Bank          |
| "              | W60                    | "                     | #6 Condenser Bank          | +180 Volt B Battery        |
| "              | W61                    | "                     | #1 Input Transformer       | P 1st A-F Socket           |
| "              | W62                    | "                     | P Detector Socket          | #1 3rd R-F Choke           |
| "              | W63                    | "                     | #2 3rd R-F Choke           | #2 A-F Coupling Condenser  |
| "              | W64                    | "                     | #2 A-F Coupling Condenser  | #1 Detector Plate Resistor |
| "              | W65                    | "                     | #2 Detector Plate Resistor | #2 Input Transformer       |
| "              | W66                    | "                     | #2 Input Transformer       | #5 Condenser Bank          |
| "              | W67                    | "                     | #5 Condenser Bank          | +135 Volt B Battery        |
| "              | W68                    | "                     | #1 Detector By-Pass Cond.  | #1 3rd R-F Choke           |
| "              | W69                    | "                     | #2 Detector Plate Resistor | #2 2nd R-F Choke           |
| "              | W70                    | "                     | #2 2nd R-F Choke           | #2 1st R-F Choke           |
| "              | W71                    | "                     | + 2nd R-F Transformer      | #1 1st R-F Choke           |
| "              | W72                    | "                     | + 3rd R-F Transformer      | #1 2nd R-F Choke           |
| "              | W73                    | "                     | P 1st R-F Socket           | P 2nd R-F Transformer      |
| "              | W74                    | "                     | P 2nd R-F Socket           | P 3rd R-F Transformer      |



## WIRING CHART FOR BATTERY RECEIVER (Continued)

| <u>CIRCUIT</u> | <u>WIRE<br/>NUMBER</u> | <u>WIRE<br/>COLOR</u> | <u>FROM<br/>TERMINAL</u>  | <u>TO<br/>TERMINAL</u>   |
|----------------|------------------------|-----------------------|---------------------------|--------------------------|
| Plate          | W75                    | Red                   | #1 1st R-F Choke          | #1 1st By-pass Condenser |
| "              | W76                    | "                     | #1 2nd R-F Choke          | #1 2nd By-pass Condenser |
| "              | W77                    | "                     | #2 Detector By-Pass Cond. | #2 2nd By-pass Condenser |
| "              | W78                    | "                     | #2 2nd By-pass Condenser  | #2 1st By-pass Condenser |

**PRACTICAL SUGGESTIONS.** The 3-gang condenser should be carefully examined before mounting it on the board. A slight adjustment to the middle set of rotor plates may be necessary in some cases to prevent the rotor plates from touching the stator plates when in the extreme zero "0" position, that is, when both sets of plates are completely out of mesh. With the plates in this relative position the condenser has minimum capacitance. A short circuit test can be made with headphones and battery. If the above condition exists it can be corrected as follows: Move the rotors about half way "out" and then firmly grasp the rotor assembly of either end condenser with one hand and with the other use screw driver handle to tap the brass plate on the middle rotor one or two quick sharp blows in a downward direction. This sudden shock is usually sufficient to shift the middle rotor around on the shaft the slight amount necessary to make the two sets of plates clear when in the extreme "out" position. It may or may not be necessary to loosen the set screws during the adjustment since in most condensers there is enough tolerance for a small shift of rotor. A shorted middle condenser would cause the filament of one 222 tube to be shorted out, with the result that the full 6 volts would be applied to the other 222 filament because of the series connection.

**HOW TO ATTACH TERMINAL POSTS FOR PHONOGRAPH PICK-UP.** For those students who desire to utilize the audio amplifier and loudspeaker for reproducing phonograph records it is suggested that two terminal posts be attached to the rear edge of the board directly in back of the detector, and then connect permanently an insulated wire from one of these posts to the grid terminal on the detector socket and a second wire from the other post to — A terminal on the same socket, or to any low potential or grounded part of the receiver circuit. To reproduce phonograph records simply attach the two leads from any pick-up attachment to the newly installed posts, turn on the switch and move the tuning dial to 100. Before operating the receiver for broadcast reception always remember to disconnect one of the pick-up attachment leads. The pick-up lead to be removed is the one attached to the post to which the grid is connected.

**OSCILLATION.** If the battery-operated receiver has a tendency toward oscillation this can be overcome by connecting the screen-grid lead to the 22½ volt tap on the "B" battery instead of to the 45 volt tap as recommended. This change in screen-grid voltage will, however, reduce the volume to some extent.

EXAMINATION - LESSON 33-A

1. What are the advantages of a push-pull amplifier?
2. (a) Has a battery-operated receiver any advantages over an a-c operated receiver? (b) Give reasons for your answer.
3. (a) What batteries are required for this battery-operated receiver, and give their voltages? (b) What circuits do they supply?
4. Name and give the function of each tube employed in this battery-operated receiver.
5. State how many volts should be supplied to the filaments of the following tubes: (a) 222 type, (b) 112-A type, (c) 171-A type.
6. In what part of a receiver would you use trimming condensers? Why?
7. How many volts would you apply to the plate of a UX-222 tube?
8. Why are screen-grid type tubes preferable for radio-frequency amplifiers?
9. How can the same storage battery be used to supply the filaments of two 222 type tubes and 112-A and 171-A type tubes in a receiver?
10. If this set tends to oscillate how would you correct this trouble?